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BULLETIN

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Vol. 44 No. 11

BULLETIN

OF THE

TORREY BOTANICAL CLUB

NOVEMBER, 1917

Relationship of the genus Kuehneola*

J. C. ARTHUR

The genus *Kuehneola* was established by Magnus† some twenty years ago to better emphasize the peculiar rust on *Rubus* having white and delicate-walled teliospores, a rust that had previously for a decade been called *Phragmidium albidum*. The colorless telia with their catenulate teliospores, so unlike rusts in general, were placed in the genus *Oidium* by Link in 1824, and in the genus *Torula* by Fries in 1832.

For a brief interval after the fungus was recognized as a rust, and before it was assigned to *Phragmidium*, or its close ally *Kuehneola*, it passed under the name of *Chrysomyxa albida*. In giving this name Julius Kühn,‡ with his usual thoroughness and insight, clearly set forth the characteristics of both urediniospores and teliospores, pointing out that in the shape and manner of formation of the delicate, cylindrical teliospores, as well as in the absence of paraphyses around the uredinial sorus, and in the general appearance of the urediniospores, there was indicated a closer relationship with *Chrysomyxa* (*Melampsoropsis*) than with *Phragmidium*.

The original *Kuehneola albida* (Kühn) Magn., now better

* Presented in part before the American Phytopathological Society at the Columbus meeting, December 29, 1915.

† Bot. Centr. **74**: 169. 1898.

‡ Bot. Centr. **16**: 154. 1883.

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called *K. Uredinis* (Link) Arth., if the earliest specific name is to be adopted (which happens to be one founded upon the telia), is now known to occur on many species of *Rubus* throughout Europe and North America, and another species, *K. andicola* (Diet. & Neg.) Diet., is found in South America on *Rubus geoides* Sm. In 1912 Dietel and the writer added three species to the genus on other rosaceous hosts, and between 1912 and 1914 Butler, Sydow and the writer added eight other species, whose hosts belong to the families Vitaceae, Artocarpaceae, Burseraceae, Anacardiaceae, Verbenaceae and Bignoniaceae. Of all these species the full life history is known for only the first species, *K. Uredinis* on *Rubus* (Rosaceae), and the last one, *K. Markhamiae* (P. Henn.) Syd. on *Markhamia* (Bignoniaceae).

The last species occurs in German East Africa. A good description is given in Sydow's Monographia Uredinearum (3: 318), but without mentioning the pycnia. These were found on an original specimen in my own herbarium. They are epiphyllous, in small groups opposite the primary uredinia, punctiform, subcuticular, 100–110 μ in diameter, the hymenium flat; ostiolar filaments wanting. The urediniospores are borne singly on pedicels, sparsely echinulate-verrucose, and with three equatorial pores.

It will be seen that the general characters of *K. Uredinis* and *K. Markhamiae* coincide, and the two species can be considered genuine representatives of the genus *Kuehneola*. Although the pycnia of *K. andicola* have not been detected, yet the similarity of the known characters, and the host being a species of *Rubus*, that species can also be included in the genus without hesitancy.

The other recorded species on rosaceous hosts are *K. japonica* Diet., on three species of *Rosa* in Japan, *K. Duchesneae* Arth., on *Duchesnea indica* (Andr.) Focke (*Fragaria indica* Andr.), in North America, and *K. obtusa* (Strauss) Arth., on three or more species of *Potentilla*, in Europe, and on *P. canadensis* L. in North America. No specimen of the species on *Rosa* has been seen by the writer, but the description, for telia only, appears to warrant its inclusion under *Kuehneola*.

In studying the species on *Potentilla*, or two species as maintained by some uredinologists, it was brought out some time since that the relationship with species of *Kuehneola* on *Rubus* is not

as close as had been assumed. The matter was especially brought to my attention by Dr. F. D. Fromme, while a member of my laboratory force, and has since been considerably elucidated. Recently the statement of Dietel,* made a number of years since, was brought to mind, and as he has covered the chief item in question very succinctly, I can not do better than present his words in English form. Dietel says: "The so-called teliospores of *Kuehneola* are spore-chains, series of one-celled single spores, which are successively abstricted one after the other from the apex of a common hypha, and remain united fast with one another." This statement by Dietel applies to the members of the genus *Kuehneola* as represented by the forms on *Rubus* and *Markhamia*, but not to the forms on *Potentilla* and *Duchesnea* that the writer placed under that genus, although there is much similarity in appearance between the two. The latter have the teliospores distinctly stalked. They are morphologically in regard to their septation like the teliospores of *Phragmidium*, under which genus they are usually placed, but have single, apically placed pores in each cell, and the spores are smooth. For such forms I propose the following new genus, named in honor of Dr. F. D. Fromme, professor of botany in the Virginia Polytechnic Institute, whose clear thinking and cogent reasoning have much enriched botanical science.

Frommea gen. nov.

Cycle of development includes pycnia, primary and secondary uredinia and telia; autoecious. Pycnia subcuticular, other sori subepidermal.

Pycnia with flat hymenium and without ostiolar filaments.

Uredinia with few or no paraphyses, the urediniospores borne singly on pedicels, pale, and with pores indistinct, usually equatorial.

Telia without paraphyses, the teliospores free, pedicelled, serially several-celled, rarely one-celled, colored, the wall smooth, the pores single and apically placed in each cell.

Type *Uredo obtusa* Strauss, on *Tormentilla erecta*.

Frommea obtusa (Strauss) comb. nov. (*Uredo obtusa* Strauss, *Phragmidium Tormentillae* Fckl., *P. Potentillae-canadensis*

* Ann. Myc. 10: 205. 1912.

Diet., *Kuehneola obtusa* Arth.), on *Potentilla sylvestris* (*P. Tormentillae, Tormentilla erecta*), *P. procumbens, P. mixta, P. reptans, P. canadensis*, Europe and North America.

In Sydow's Monographia Uredinearum (**3**: 105, 106), where the primary uredinia are described as aecia, the European and American forms are assigned to separate species distinguished by the different number of cells in the teliospores, but in the examination of a large number of collections of each no such difference has been detected. The description of the type species by Strauss is that of the telia, and his illustration shows a teliospore, although Strauss placed his species under Uredo.

Frommea Duchesneae (Arth.) comb. nov. (*Kuehneola Duchesneae* Arth., *Phragmidium Duchesneae* Syd.), on *Duchesnea indica*, North America.

Frommea Polylepidis sp. nov., on *Polylepis* sp., Corazon, Ecuador, October, 1891, *G. Lagerheim*.

Uredinia hypophyllous, scattered, round or oblong, 80–160 μ across, soon naked, somewhat pulverulent, dirty white, ruptured epidermis evident; paraphyses none, urediniospores obovoid or ellipsoid, 10–16 by 19–25 μ; wall light yellow to colorless, 1–2 μ thick, evenly and moderately verrucose-echinulate, the pores obscure.

Telia unknown.

The genus *Frommea* differs from *Phragmidium*, not only in having nearly or quite smooth teliospores, with one apical pore in each cell, instead of tuberculate teliospores with more than one pore and lateral in each cell, but also in possessing no aecia proper with catenulate spores, but instead having primary uredinia with pedicellate spores. The primary uredinia are circinnate about the pycnia, epiphyllous, large and much resembling in gross appearance the caeoma of a *Phragmidium*.

The next group of species to be considered consists of the two species on Malvaceae, placed by the writer under *Kuehneola* in 1912 (N. Am. Flora **7**: 187), and accepted as such by subsequent writers. The discovery of the telia in this group was made in March, 1911, by Mr. C. R. Orton, then a member of the laboratory force, now assistant professor of botany in the Pennsylvania State College, who found them on *Malvaviscus Drummondii* T. &

G., collected at Austin, Texas, October 31, 1909, *Heald & Wolf 372*. Since then they have been found on two collections of *Malvaviscus*, *M. arboreus* and *M. mollis*, from Guatemala. These three collections are the only ones yet known to show telia for *K. malvicola*.

All three collections show abundance of the telia, which agree in their appearance and form with the published description. The long filiform spore chains do not readily separate into single cells, even after germination. They spread apart, however, even to the hymenial point of attachment in the sorus, showing that there is no tendency to lateral agglutination. The walls are distinctly cinnamon-brown, and in this character, as well as the negative fact that pycnia are unknown, the species fails to accord with the species of *Kuehneola* on *Rubus* and *Markhamia*, but the agreement is so marked in the more essential characters, that the species may for the present be considered correctly placed under the genus *Kuehneola*.

When telia on *Gossypium* were found by Mr. Orton in May, 1911, it was natural to suppose they would fall readily into the same genus as the other malvaceous form had done, especially as the characters of the uredinium were practically in agreement. Both species have delicate, uniseriate teliospores. In the *Gossypium* rust, however, the spores are adherent laterally, and the end cells of all the spore chains fall away readily, producing a short columnar telium that becomes pulverulent at the extremity. In the form of the telium it simulates that of *Cronartium*, only being short, scarcely higher than broad, instead of being excessively long. The teliospores are colorless, not tinted as in *K. malvicola*.

The telia of the *Gossypium* rust in color, habit of spores, and general form, agree well with those of *Cerotelium*, the only fully recognized species of which, *C. Canavaliae*, is on a fabaceous host. The uredinia of the *Gossypium* and *Canavalia* rusts are not unlike, except that the former has delicate, peripheral paraphyses, imbricated over the sorus, most readily seen when still unopened while the latter has a delicate peridium of polygonal cells, also most readily seen in the unopened sorus. In both cases the uredinial envelope breaks away and becomes more or less evanescent after the sorus opens.

There remain the following species assigned to *Kuehneola: K. Vitis* (Butl.) Syd. (Vitaceae), *K. Butleri* Syd. and *K. aliena* Syd. & Butl. (both Anacardiaceae), *K. Fici* Butl. (Artocarpaceae), and *K. peregrina* Syd. & Butl. (Verbenaceae), for none of which has the writer seen an authentic collection. In the case of *K. Fici* the writer has already followed the lead of Butler* and Sydow† and accepted the statement made by Butler that the uredinial stage so common on the cultivated fig and other species of *Ficus* in the tropics is identical with the form associated with telia occurring in India on *Ficus tomentosa*, and has so listed collections from the West Indies.‡ Carefully reviewing the excellent description and figures given by Butler, it seems that the *Ficus* rust has a telial structure essentially the same as that of the *Gossypium* rust, and should be assigned to the same genus. The same reason holds for a similar treatment of *K. Vitis* and *K. Butleri*. In the case of *K. aliena* and *K. peregrina* no paraphyses for the uredinium are described, but in all other respects the descriptions indicate a similar rust. Whether in this case paraphyses are entirely absent, or only to be seen by special manipulation, the writer has no way of ascertaining.

By this interpretation of generic characters only five species remain in the genus *Kuehneola*, out of the dozen or more which have heretofore been assigned to it. They are three with hosts in Rosaceae (*K. Uredinis*, *K. andicola*, *K. japonica*), one in Bignoniaceae (*K. Markhamiae*), and one in Malvaceae (*K. malvicola*). The greatest importance is here attached to the structure of the telium, less to the urediniospores, and least to the absence or presence of peridium or paraphyses in the uredinium.

This last item indicates an entire change of opinion by the writer regarding the value of characters drawn from the protective structures of the uredinium for generic diagnoses. A strong factor in founding the genera *Physopella* and *Bubakia* in 1906§ was the belief that the nature of the paraphyses or peridium, or their absence, was of high generic value, and the same opinion has more than once been reaffirmed.‖ Recent studies of rusts with in-

* Ann. Myc. **12**: 76. 1912.
† Monog. Ured. **3**: 323. 1914.
‡ Mycol. **8**: 174. 1916.
§ Result. Sci. Congr. Bot. Vienne 338.
‖ Mycol. **7**: 173. 1915; **9**: 59. 1917.

dehiscent, lenticular telia of the *Schroeteriaster-Phakopsora* appearance have entirely reversed this view. It has been found that with all other characters in essential agreement, the uredinium may have a membranous peridium opening by a central pore (e. g., *Phakopsora punctiformis* Diet.), or imbricated paraphyses united at their bases forming a pseudo-peridium opening by a central pore (e. g., *Phakopsora Pachyrhizi* Syd.), or a circle of hyphoid or incurved paraphyses often not higher than the spore mass (e. g., *Phakopsora Vitis* Syd.), or neither peridium nor paraphyses (e. g., *Bubakia Crotonis* Arth.).

The same situation appears to prevail in the genus *Cronartium*, as indicated by recent studies not yet published of tropical American material. The same appears to be true of the expanded genus *Cerotelium* and to some extent of the contracted genus *Kuehneola*, as here outlined. These four genera appear to be closely related, having a like development of the uredinium with its several forms of protective envelope or none, and a characteristic telium for each. Only in *Kuehneola* has the life cycle for some species been completed, and when this is done for the other genera, of course it is possible that some further shifting or emendation may be required.

The following outline is presented to bring together in closer view the several groups of rusts considered in this paper. All short-cycle forms are excluded from consideration. The type species of the genus is given in each instance, and also the type species of genera reduced to synonymy. Under *Cerotelium*, *Kuehneola*, and *Frommea*, all species known to the writer which may be correctly placed under these genera, are here listed, but under *Phakopsora* and *Cronartium* only such species are given as are considered especially illustrative, or call for transfer from other genera. Other species heretofore published and accepted under *Phakopsora* and *Cronartium*, possessing known telia, such as given in the third volume of Sydow's Monographia Uredinearum, have not been listed.

Only in a few instances is it possible to assign forms to their respective genera when only the uredinia are known. The attempts to do so by the Sydows (*Kuehneola Garugae* and *Phakopsora Juelii*), as well as those by the writer under the genus *Physopella*

(*P. Maclurae*, *P. Cherimoliae*, and *P. Artocarpi*), must be considered premature and exceedingly hazardous. Many forms described under *Uredo*, which almost certainly belong under one of the genera here presented, must await the discovery of telia for further assortment.

UREDINACEAE (MELAMPSORACEAE)

Telia laterally expanded, lenticular or discoid, indehiscent, the teliospores one-celled, catenulate with few spores in a chain, compacted; uredinia with delicate, cellular peridium, with peripheral, free or imbricated paraphyses or neither, the urediniospores sessile, apparently produced in chains with one spore maturing at a time and falling away before the next one enlarges..... PHAKOPSORA

PHAKOPSORA PUNCTIFORMIS (Barcl. & Diet.) Diet. (type of *Phakopsora*), on *Galium Aparine* (Rubiaceae), India.

Phakopsora alpina (Schröt.) comb. nov. (*Uromyces alpinus* Schröt., type of *Schroeteriaster*), on *Rumex alpinus* (Polygonaceae), eastern Europe.

PHAKOPSORA VITIS (Thüm.) Syd. (type of *Physopella*), on *Parthenocissus* and *Vitis* spp. (Vitaceae), Japan, possibly including all forms in tropical America where no teliospores have yet been found.

Phakopsora fenestrala (Arth.) comb. nov. (*Uredo fenestrala* Arth.), on *Phyllanthus distichus*, *P. grandifolius* and *P. Niruri* (Euphorbiaceae), Porto Rico.

Phakopsora Crotonis (Burr.) comb. nov. (*Schroeteriaster Crotonis* Diet., type of *Bubakia*), on *Croton* and *Crotonopsis* spp. (Euphorbiaceae), North America.

Phakopsora mexicana (Arth.) comb. nov. (*Bubakia mexicana* Arth., *Schroeteriaster mexicanus* Syd.), on *Croton* spp. (Euphorbiaceae), Mexico.

Phakopsora argentinensis (Speg.) comb. nov. (*Schroeteriaster argentinensis* Syd.), on *Croton* sp. (Euphorbiaceae), South America.

Phakopsora stratosa (Cooke) comb. nov. (*Schroeteriaster stratosus* Syd.), on *Croton sylvaticus* (Euphorbiaceae), Southern Africa.

Phakopsora Glochidii (Syd.) comb. nov. (*Schroeteriaster Glochidii* Syd.), on *Glochidium zeylanicum* (Euphorbiaceae), Formosa.

Phakopsora Brideliae (Koord.) comb. nov. (*Uredo Brideliae* Koord., *Schroeteriaster cingens* Syd.), on *Bridelia* spp. (Euphorbiaceae), Philippines, Java, India.

Phakopsora Meibomiae (Arth.) comb. nov. (*Physopella Meibomiae* Arth.), on *Meibomia* spp. (Fabaceae), West Indies.

Phakopsora Vignae (Bres.) comb. nov. (*Uredo Vignae* Bres., *Physopella concors* Arth.), on *Vigna lutea* (host of type), *Phaseolus lunatus*, *Dolichos Lablab*, *Teramnus uncinatus* (Fabaceae), West Indies. The teliospores of this species are not yet known.

Phakopsora Crotalariae (Diet.) comb. nov. (*Uredo Crotalariae* Diet.), on *Crotalaria* sp. (Fabaceae), Rio Janeiro. The telia were found on a part of the original collection, made by E. Ule at Copacabana, on the bay of Rio de Janeiro, Brazil, in August, 1897. They are subepidermal, inconspicuous, lenticular, about 4 or 5 spores deep, the spores compact, angular, about 10–15 μ in diameter, the wall 1.5 μ thick, cinnamon-brown. The uredinia have imbricated paraphyses and urediniospores very similar in size and form to those of *Phakopsora Vignae*.

Phakopsora Aeschynomenis (Arth.) comb. nov. (*Uredo Aeschynomenis* Arth.), on *Aeschynomene* spp. (Fabaceae), Mexico, West Indies and South America. The teliospores are not yet known.

Telia erect, verruciform, not much longer than broad, erumpent, somewhat waxy, becoming pulverulent at the surface, the teliospores one-celled, catenulate with few spores in a chain, the terminal spores readily separating upon germination; uredinia as in the preceding..... CEROTELIUM

CEROTELIUM CANAVALIAE Arth. (type of *Cerotelium*), on *Canavalia ensiformis* and *C. gladiata* (Fabaceae), Porto Rico.

Cerotelium Fici (Cast.) comb. nov. (*Uredo Fici* Cast., *Uredo ficina* Juel, *Physopella Fici* Arth., *Kuehneola Fici* Butl.), on *Ficus* spp., *Toxylon pomiferum*, *Broussonetia papyrifera*, *Morus indica* (Artocarpaceae), in all tropical regions, chiefly as uredinia.

Cerotelium Vitis (Butl.) comb. nov. (*Chrysomyxa Vitis* Butl., *Kuehneola Vitis* Syd.), on *Ampelocissus latifolia* (Vitaceae), India.

Cerotelium Gossypii (Lagerh.) comb. nov. (*Uredo Gossypii* Lagerh., *Kuehneola Gossypii* Arth.), on *Gossypium* spp. (Malvaceae), tropical Asia and America.

Cerotelium peregrinum (Syd. & Butl.) comb. nov. (*Kuehneola peregrina* Syd. & Butl.), on *Clerodendron* sp. (Verbenaceae), India.

Cerotelium Lanneae (Höhn.) comb. nov. (*Uredo Lanneae* Höhn., *Kuehneola Butleri* Syd.), on *Odina Wodier* (Anacardiaceae), India and Java.

Cerotelium Spondiadis (Petch) comb. nov. (*Uredo Spondiadis* Petch, *Kuehneola aliena* Syd. & Butl.), on *Spondias mangifera* (Anacardiaceae), India.

Cerotelium Eviae (Rac.) comb. nov. (*Dietelia Eviae* Rac.), on *Spondias* (*Evia*) spp. (Anacardiaceae), Java. It is possible that this and the preceding species, *C. Spondiadis*, may be identical.

Telia erect, filiform, erumpent, waxy, becoming corneous, the teliospores one-celled, in long, indistinguishable chains, not separating upon germination; uredinia as in the preceding..... CRONARTIUM

CRONARTIUM FLACCIDUM (A. & S.) Wint. (type of *Cronartium*), on *Asclepias* spp., etc. (Asclepiadaceae, etc.), Europe and Japan.

CRONARTIUM BYRSONIMATIS P. Henn., on *Brysonima coccolobifolia* (Malpighiaceae), South America, a species with uredinia having imbricated paraphyses.

CRONARTIUM ZIZYPHI (Pat.) Syd. & Butl., on *Zizyphus* sp. (Rhamnaceae), India, a species with uredinia having imbricated paraphyses.

Telia erumpent, velvety, the teliospores one-celled, catenulate with many spores in spreading, free chains; uredinia apparently as in the preceding, but the paraphyses hyphoid, inconspicuous, or none; pycnia accompanying primary uredinia. KUEHNEOLA

KUEHNEOLA UREDINIS (Link) Arth. (type of *Kuehneola*), on *Rubus* spp. (Rosaceae), North America, Europe, and Southern Africa.

KUEHNEOLA ANDICOLA (Diet. & Neg.) Diet., on *Rubus geoides* (Rosaceae), South America.

KUEHNEOLA JAPONICA Diet., on *Rosa* spp. (Rosaceae), Japan.

KUEHNEOLA MARKHAMIAE (P. Henn.) Syd., on *Markhamia* sp. (Bignoniaceae), East Africa.

KUEHNEOLA MALVICOLA Arth., on *Malvaviscus* and *Hibiscus* spp. (Malvaceae), tropical America.

AECIDIACEAE (PUCCINIACEAE)

Telia erumpent, the teliospores free, pedicellate, cells uniseriate or rarely one, the pores one in ea_h cell and placed apically; uredinia both primary and secondary, no paraphyses or peridium with the former, inconspicuous peripheral paraphyses with the latter, or none; pycnia accompanying primary uredinia.... FROMMEA

FROMMEA OBTUSA (Strauss) Arth., on *Potentilla* spp. (Rosaceae), North America and Europe.

FROMMEA DUCHESNEAE Arth., on *Duchesnea indica* (Rosaceae), North America.

FROMMEA POLYLEPIDIS Arth., on *Polylepis* sp. (Rosaceae), South America.

PURDUE UNIVERSITY,
LAFAYETTE, INDIANA

The guavas of the Hawaiian Islands

VAUGHAN MACCAUGHEY

The guavas comprise a valuable and widely distributed genus (*Psidium* L.) of tropical and subtropical fruit trees and shrubs. They are indigenous to America, but numerous species are now thoroughly established in many of the warmer parts of Africa, Asia, Oceanica, and other regions. There are about 150 known species, and presumably a large number of forms in South and Central America that are still undescribed.

Seven or more species and forms have been established in the Hawaiian Archipelago since early times and now constitute an important element in the lowland flora. The Hawaiian Islands were discovered by the Spanish in 1555, over two hundred years before the discovery by the great English circumnavigator, Captain Cook. Although historical data concerning these two centuries is very scanty, there is little doubt but that the Spaniards visited the islands repeatedly, and accidentally or purposely introduced various Mexican, Central American, and West Indian plants. The common guava in its several forms was introduced either during this period or within a relatively short time after the discovery by Cook. It was spread rapidly from island to island and locality to locality and has now become a dominant woody weed in many lowland, valley, and foothill regions. It possesses all the attributes essential for aggression—great hardihood with reference to untoward conditions; rapid growth; deep roots; ability to thrive on scanty water supply; power of flourishing on rough, rocky ground; production of sturdy root-sprouts in great numbers; prolific and almost continuous fruit production, with vast numbers of viable seeds; resistance to insect and fungus pests; notable powers of dissemination.

The fruits of all the species are attractive to animals, and the seeds of the wild guavas are widely scattered throughout the islands, both on the lowlands and in the mountains, by means

of wild and domestic live-stock and birds. The Chinese dove (*Turtur chinensis*), mynah bird (*Acridotheres tristis*), rice bird (*Carpodacus mexicanus obscurus*), sparrow (*Passer domesticus*), Chinese reed-warbler (*Trochalopterum canorum*), and other introduced birds, as well as the steadily decreasing indigenous birds, all feed freely upon the guavas, and disseminate them to the most remote regions. The wild swine, goats, sheep, and cattle also feed upon the fruits, and assist in the distribution of these ubiquitous plants. Numerous insects, especially of the Orthoptera, gnaw holes in the ripening fruit, and devour the pulpy interior.

As a result of their marked adaptability to local conditions the Hawaiian guavas have become serious pests, particularly on the arable lands. The wild guava, together with Hawaii's other chief woody pest, the lantana (*Lantana Camara* L.), occupy thousands of acres, to the practical exclusion of indigenous vegetation. The main guava zone is in the lowland area, including the valleys, ridges, and foothills, up to an elevation of about 300 meters. Isolated trees are not uncommon above this level, but the great tracts of almost unbroken guava "scrub" lie below it. On the islands of Maui and Hawaii, which rise to 3,000 and 4,200 meters, respectively, the upper limit of the guava scrub is usually about 100 meters, but the general proportions of the zones are about the same as on the lower islands.

Land desired for agricultural purposes, that has become overgrown with guava scrub, is very difficult to clear. The roots are so deep, tough, and interwoven that their removal necessitates arduous hand labor; they cannot be plowed up by ordinary methods. Moreover, the roots are so long-lived, even when cut into fragments, and sprout so freely, that every piece must be removed from the soil if the clearing is to be permanent. In hurried or careless clearing of the land, when many roots are left, they quickly send up vegetative shoots and again take possession of the soil. So laborious is the clearing of guava-land that the usual contract price, in the vicinity of Honolulu, is from fifty to one hundred dollars per acre, varying with the density of the scrub and the stoniness of the land.

On side-hills and valley slopes and other waste land that has

no agricultural value, the guava, like its close associate the lantana, is a beneficial plant. It improves the soil, both in physical character and in nutritive content; it checks erosion; and gradually ameliorates otherwise barren and unattractive areas. The guava is a successful and valuable pioneer, although difficult to eradicate when the land is needed for other purposes. The great areas of guava scrub that are distinctive of so many of Hawaii's lowland regions have a commercial value as bee-pasture. The flowers are fragrant and highly nectiferous, and yield an excellent grade of honey. The wild guava has high rank among the honey-plants of Hawaii.

In addition to the wild forms of guava, which are so common throughout the lowlands, there are a number of choicer varieties occurring only in cultivation. These are restricted to the larger estates, tropical gardens, and older plantations, where the less common tropical economic plants receive special consideration. The Hillebrand gardens, the Moanalua estate, the Jaeger gardens, Ainhau, and gardens in the older settlements at Waimea, Lahaina, Kohala, and Hilo, are examples of situations where these less generally known forms are to be found.

The genus *Psidium* is myrtaceous, and nearly related to *Myrtus*, *Eugenia*, and *Punica*. The generic name is from the Greek *psidion*, meaning pomegranate, a fanciful reference to the fruit. Guava is from the native Guiana name, *guayaba*. The genus comprises low-growing trees or shrubs, characterized by leaves which are opposite, petiolate, glabrous, pubescent or tomentose, and pinnately veined. The flowers are solitary or few (one to three, rarely many), on axillary or lateral peduncles; they are usually rather large and whitish. The calyx-tube is urceolate or pyriform, adnate at the base; lobes four or five, persistent; upper free portion entire and sometimes closed over the flower in the bud, and later coming off entire or splitting irregularly into two to five lobes. The petals are four or five, free and spreading. The stamens are numerous, disposed in many series and inserted upon the disk; filaments filiform; anthers oblong or linear, basifixed, and longitudinally dehiscent. The ovary has two to seven, commonly four, locules, with many ovules in each locule, inserted on bifid, axile placentas. The style is slender, the stigma

peltate or subcapitate. The fruit is a berry, in shape ovoid, globose or pyriform, and about 2.5–7.5 cm. long and crowned with the calyx-limb. The skin is thin and delicate, yellow to red in color, sometimes green. The seeds are few to numerous, small, hard, kidney- or horseshoe-shaped; the embryo curved, with a long radicle and short cotyledons. The guavas are all readily propagated from seed, and often fruit the second year from seed. The fruit of none of the horticultural forms is suitable for shipping, as it is too delicate, and ripens too quickly.*

The Common Yellow Guava

This species, *P. Guajava* L., in its several forms, is the most abundant representative of the genus in the Hawaiian flora. It is also called lemon guava, or wild guayaba although these names are not distinctive. The Spanish name is *guayaba*, and the aboriginal Mexican name, *xalxocotl*. It ranges from Mexico to Central America and Peru. It is highly variable, and has many horticultural forms, which are not thoroughly known. The two varieties that are commonly given in the literature, "*pomiferum*" and "*pyriferum*," referring to the shape of the fruit, are no longer given botanic status, as they represent indefinite variations. In California a variety is known to the trade as "Hawaiian Guava"—it has a yellow skin and pink flesh—but has not been demonstrated to be a genuine variety.

* Engler & Prantl (Nat. Pflanzenfam 3^7: 67–69), give the following characterization of the genus:

Psidium L. (*Acca* Berg, *Calyptropsidium* Berg, *Mitranthes* Berg z. T.) Blütenachse meist gestreckt, ± über den Frkn. hinaus verlängert. Kelch verwachsenblättrig, beim Aufblühen mit meist bis zum Staminaldiscus reichenden Längrissen in die einzelnen B. oder unregelmässig zerreissend, sehr selten haubenartig abgesprengt. A. oval bis linear, dorsifix. N. knopfig; meist 4–5 (2–7) Frb., die nicht ganz bis zur Achse verwachsen, so dass die Placenten parietal bleiben und in jeder Kammer einen oblongen Kranz bilden.—Alles übrige wie bei *Myrtus;* nur die (meist behaarten) B. und die Bl., überhaupt die ganzen Pfl., durchschnittlich kräftiger.

Their synopsis of the genus, with typical species, is:

Sect. 1. Apertiflora Ndz.
- *A.* Oblongifolia Ndz.: *P. ciliatum* Benth.; *P. aromaticum* Aubl.
- *B.* Obversifolia Berg.: *P. Cattleyanum* Sabine.
- *C.* Albotomentosa Berg: *P. incanescens* Mart.; *P. grandifolium* Mart.

Sect. 2. Calyptrata Ndz.
- *A.* Integrifolia Ndz.: *P. Guayava* Raddi; *P. Araça* Raddi.
- *B.* Crenatifolia Berg: *P. striatulum* DC.; *P. fluviatile* Rich.

Sect. 3. Calyptropsidium Berg: *P. eugenioides* (Comb.) Ndz.

The common guava is an arborescent shrub or small tree, sometimes rising to the height of 9–12 m., but usually only 3–6 m. The trunk is slender, and usually divides close to the ground into a number of sinuous stems. The outer bark exfoliates in large brittle flakes or scales, exposing the beautiful smooth, greenish brown inner bark. The mottled trunk of the guava is very attractive and has distinct ornamental value. The young branches are pubescent and four-angled or winged. The leaves are ovate to oblong-elliptic, 8–15 cm. × 5–7 cm.; apex usually acuminate, base rounded; light green, chartaceous, glabrous above, soft pubescent beneath. The principal veins are very prominent, impressed above and raised below. The petiole is short, 5–7 cm. in length.

The flowers occur on the branches of recent growth; they are white, fragrant, and in clusters of one to three on axillary peduncles 1–2.5 cm. long. The pedicels are about 1.5 cm. long, and bear two small, slender bracts at the upper end. The calyx-tube is oblong-ovate, slightly constricted above the ovary. The calyx is closed before anthesis, splitting into two to four irregular segments, whitish and sparsely hairy within. The petals are broadly oval, about 1.5 × 1 cm., thin, delicate, and white. The stamens are erect or spreading, in a broad cluster; filaments 1 cm. long, anthers pale yellow. An abundance of nectar is produced.

The fruit is globose, ovoid or pyriform. It is 7–10 cm. long, and weighs 140–225 g. The rind is somewhat rough, and changes in color from dark green to brownish yellow and finally to clear, deep yellow. The flesh is whitish, yellowish, or dark pink, usually the latter, and comprises two regions—an outer layer, just beneath the rind, which is firm and finely granular; and a more extensive inner mass, of soft, juicy material. The flavor is sweet or somewhat acid; the distinctive feature is the pronounced musky aroma, which is very penetrating. This aroma, which is highly developed in fully mature fruit of good quality, is very agreeable to some people and quite unpleasant to others. The seeds are numerous, reniform or flattened.

The common guava is the chief source of the guava jelly of commerce. Large quantities of guava jelly and jam are manufactured locally, by the orientals, Portuguese, and others. Every

little wayside Chinese shop carries a stock of guava jelly. An excellent grade of jelly is made by the American preserving firms for local use and for export to the mainland. However, the manufacture of guava jelly is not as important an industry in Hawaii as it is in many other tropical countries, such as the West Indies, South America, and India. "Goiabada" is made and sold in large quantities in Brazil; it is a thick guava jam. A similar stiff paste is sold in the West Indies and Florida as "guava cheese." Guavas are offered for sale in the various local island markets, and in Honolulu are peddled from door to door by the Portuguese children, who gather the wild fruit. The wide range of guavas in the dietary of white people living in the tropics is well indicated by reference to standard Honolulu cookbooks,* where many recipes are given.

In the Hawaiian Islands the guava is so common as a weed of the roadsides and wastelands that little attention is given to its culture. Dependence is placed upon the abundant supply of wild fruit, rather than upon planted trees. In India, the West Indies, and other countries where this species is not so abundant, the trees are easily raised from seed. The seedlings are transplanted when two or three years old, and bear fruit one or two years after planting. Occasionally a plant will bear fruit the second year from seed, but this is unusual. The prolific production of root-sprouts has been mentioned; this habit affords a very easy method of propagating the plant.

The guava is used in parts of India for dyeing. By boiling the leaves and bark with certain other plants, a black color is obtained, and used for dyeing yarn or cloth. The leaves, either alone or with mango leaves, are used by the poorer classes for tanning. Astringency is a characteristic property of the plant, and the roots, leaves and fruits are utilized medicinally for diarrhoea, scurvy, and similar ailments. The leaves are commonly used in India in the preparation of poultices.

Guava wood is whitish or pale yellowish, moderately hard, even- and close-grained, and weighs about 42 lbs. to the cubic foot. It works easily and smoothly, and takes a beautiful polish. In

* See, for example, Turner, Jessie C., & Alexander, Agnes B. How to use Hawaiian fruits, 30–34. Honolulu. 1910.

some countries it is used for tools, spear handles, etc., but has no special uses of this kind in Hawaii. Here it is of much importance as a source of charcoal, and is cut and prepared by the orientals for this purpose. In excursions across country through the guava scrub, one commonly passes the little huts and furnaces of the charcoal burners and finds the men and women themselves, laboriously cutting the saplings, reducing them to proper length, and tending the adobe furnaces.

The Mediterranean fruit-fly (*Ceratitis capitata*), which before the introduction of its insect parasites* seriously infested a great variety of both native and introduced fruits in Hawaii, was exceedingly plentiful in the guavas. It attacked all of the local forms, but was particularly abundant in the strawberry guava and the wai-awi guava. For a number of years, until the introduced parasites became effective in their control work, there were comparatively few uninfested guavas in the region of Honolulu and its adjacent valleys. An estimate, based upon the examination of thousands of fruits in the field during this period, would indicate that eighty per cent. of the guavas at any given time were infested by the fruit-fly. During the past two years, 1915–16, the infestation has not been so serious, owing to a gradual readjustment of the pest to control factors.

The common white mealy bug (*Pseudococcus nipae*), which infests the grape, fig, avocado, annonas, etc., and several species of aphids are very common on the guava foliage. Their favorite habitats are along the prominent veins, on both surfaces of the leaves. They are most abundant on the older leaves, as the very young leaves are quite tomentose. The cottony guava scale (*Pulvinaria psidii*), and the pepper-tree scale (*Aspidiotus lantaniae*) are also plentiful on both wild and cultivated guavas. Fuller's rose beetle (*Aramigus fulleri*) feeds to a great extent on guavas on the islands of Molokai and Hawaii. A bark beetle (*Xyleborus affinis*) is recorded as attacking the wild guavas on Kauai, especially the wai-awi variety.

A number of fungus diseases occur on the guava, but none are apparently of any serious detriment to the plant. The common sooty mold (*Meliola Camelliae* [Catt.] Sacc.) which infests a wide

* *Galesus silvestrii* Kieffer, *Dirhinus giffardii* Silv., and *Opius humilis* Silv.

variety of plants in Hawaii—banyan, fig, avocado, citrus fruits, and others—is exceedingly pestiferous on the guava in many districts. It coats the foliage and young branches with an ugly black incrustation and is obviously an inhibiting factor in photosynthesis, transpiration, and respiration.*

The guava fruit-rot is caused by *Glomerella Psidii* (G. Del.) Sheldon, and is more or less common in the West Indies, Florida, and California. This fungus is closely related to the most destructive apple disease in the United States, namely the bitter-rot (*G. rufomaculans* [Berk.] Spaulding & Van Sch.).† The guava fruit-rot first appears as brown decaying spots here and there on the rind. These diseased areas are finally covered with masses of salmon-pink spores. As the fungus continues its activity within the fruit, the latter gradually rots, and becomes wrinkled and shrunken. This disease is not prevalent in Hawaii.

2. The Sweet Red Guava

This is a variety of the common yellow guava and has the general characters of the latter. It requires a more humid habitat and is characteristic of the upper valleys, ravines, and higher levels. The flesh is deep pink, and is firm and sweet. This form may be the classical "*pomiferum*" variety.

3. The White Lemon Guava

This is a cultivated variety of *P. Guajava*, and occurs in a number of the island gardens. The shrub usually grows more erect and arborescent in habit than do the others in this group. The fruit is pyriform (the "*pyriferum*" variety of the literature), and often is three inches in length. The skin is rough and greenish white or yellowish in color. The flesh is white, and quite sweet in flavor, with a delicate aroma. This is a choice fruit for eating out of hand, or for serving sliced on the table.

4. The Wai-awi Guava

The so-called "white guava" was introduced into the islands at a very early date and is now abundant. It often occurs far

* See Webber, H. J. Sooty mold of the orange and its treatment, U. S. Dept. Agr. Div. Phys. & Path. Bull. 13: 1–34. *pl. 1–5.* 1897.

† See Halsted, B. D. Laboratory studies of fruit decays. N. J. Agr. Expt. Sta. Rept. 1892, 326–330.

up in the mountains and ravines, surrounded by indigenous vegetation, and giving no hint of its exotic origin. It is quite distinct from the common guava, in habit, foliage, and fruit, and undoubtedly deserves specific, or at least subspecific, rank. It is a graceful, symmetrical, tall shrub or tree, with smooth trunk and branches, and a handsome crown of very dark green, glossy foliage. In favorable situations, where the humidity is sufficient, the wai-awi guava attains a height of 6–12 m., although ordinarily it is 3.5–6 m. The leaves are small, oval, smooth and glossy, and are crowded towards the ends of the branches. The sprays of foliage are of distinct beauty. The flowers are white and very fragrant. The wai-awi guava is a prolific producer of fruit, and bears more or less continuously throughout the year. The fruit is small, 2.5–5 cm. long, ovoid, and thin-skinned. It is rich, clear yellow in color, and the flesh is yellow and juicy. This variety does not form continuous scrub stands, but grows here and there, as isolated individuals or in small clumps. The birds feed eagerly upon its fruits and have carried it into nearly all the valleys.

An interesting feature of the guava in Hawaii is that numerous forms of the endemic and highly precinctive arboreal molluscs (*Achati nellidae*), have migrated onto the guavas. Messrs. J. S. and Oliver Emerson, who have made large collections of the Hawaiian snails, report that *Achatinella phaezona*, *A. fulgens* and its *plumata* pattern, *A. cestus* and *A. rutila*, all occur in the wai-awi guava, in such regions as Ke-awa-awa, Niu, and Wailupe Valleys. On the common guava they have found *A. stewartii* (*adusta* pattern), *A. turgida*, and *Auriculella pulchra*, the latter being exceedingly plentiful. The nomenclature is that of Cooke and Pilsbry.

5. The Guisaro Guava

The *guisaro*, *P. molle* Bertol., is also known as the sour *guisaro*, or *guayaba acida*. It is native to Mexico and Central America but has been introduced into Florida and California. It was introduced into the Hawaiian Islands by Mr. A. Jaeger, and specimens occur in Honolulu gardens. The *guisaro* is a low-growing, slender, straggling shrub or small tree. The young branchlets, peduncles, and lower surfaces of the leaves are reddish velvety. The leaves are oval-oblong, 7.5–12 cm. long, apex

apiculate, base obtuse or shortly acute; stiff, chartaceous, light green, rough or puberulent. The peduncles are erect and three-flowered. The flowers are white and fragrant. The fruit is abundant; spherical, 2.5 cm. in diameter; the rind is brownish green, becoming pale yellow when mature.* The flesh is white, acid, and inferior in quality and aroma. This species is not recommended for planting, as its fruits lack the rich flavor of *P. Guajava*.

6. The Red Strawberry Guava

This species, *P. Cattleianum* Sabine, is also known as the Chinese guava, or purple guava. It is a native of Brazil and is there called *araça de praya*. It is one of the hardiest species. Within relatively recent years it has been introduced into Florida, California, and Hawaii. Like the others, it is a shrub or small tree, 5–8 m. high. The bark is smooth and greenish brown; the branchlets are glabrous. The leaves are obovate-elliptic, 6–9 cm. long, apex acute, base acute to cuneate; thick and leathery, dark green, and glossy. Like the wai-awi guave, it is in flower and fruit almost continuously throughout the year. The peduncles are axillary and one-flowered; the flowers are white and fragrant. The calyx-tube is turbinate, four- to five-lobed; the lobes are broadly oblong; petals obovate, thin; style slender; stigma peltate; ovary four-locular.

The fruit is spherical or ovate, 2.5–3.5 cm. in diameter; rich dark purplish or claret red when mature. The skin is very thin and tender. The flesh is soft, juicy, and melting in texture; it is reddish next to the skin and white toward the center. The flavor is very fine, acid-sweet, and aromatic, and likened to that of the strawberry. It lacks the pungency of *P. Guajava*. There are many small, hard seeds. The sugar content of the guava is not high. The strawberry guava contains more acid than the other varieties but is less acid to the taste.

Although very satisfactory for jellies and jams, the strawberry guava is too fragile for shipment as fresh fruit. The Hawaii Station* carried on some cold storage experiments, which were summarized as follows:

* Wilcox, E. V., & Hunn, C. J. Cold storage for tropical fruits. Haw. Agr. Exp. Sta. Press Bull. 47. 1914.

A few fruits of the strawberry guava (*Psidium cattleianum*) were placed in cold storage in the 32° and 36° F. rooms. This fruit is one of the preferred host plants of the fruit fly, and a part of the fruit used in the experiment was infested. The fruit was picked in a nearly ripe condition. The strawberry guava is not well adapted to cold storage. Practically all of the fruit was shriveled and fermented or decayed within one month in both the 32° and 36° F. rooms. Mildew developed abundantly on the rind and only a few of the fruits kept their normal flavor and appearance more than two weeks.

Analyses of various Hawaiian fruits were made by the Hawaii Agricultural Experiment Station in 1914, and the guavas were reported as follows, the numbers representing percentages:

Name	Edible portion	Total solids	Ash	Total sugars	Fat	Fiber
P. Guajava						
Common.....	84.69	17.78	.531	7.38	.524	4.445
White.....	87.76	18.75	.676	8.26	.412	5.105
Trinidad.....	86.62	15.43	.651	6.34	.353	4.425
P. Cattleianum						
Chinese.....	98.01	20.08	.635	10.01	.418	3.868
Common.....	98.60	18.27	.743	4.46	.554	6.146
Common.....	81.16	23.75	.755	5.63	.790	9.378

7. The Yellow Strawberry Guava

This is *P. Cattleianum* var. *lucidum* Hort., often listed in the trade catalogues as *P. lucidum*, *P. chinense*, and *P. sinense*. It is sometimes called Chinese guava. It is occasionally cultivated in the Hawaiian Islands, but is not common, and does not occur wild. It is a low-growing shrub, with obovate leaves, white flowers, and fruit spherical, 3–3.5 cm. in diameter, and deep sulfur yellow in color. The flesh is sweet, yellow, and more delicately flavored than that of the species.

There are several other species of guava that are of horticultural importance in other parts of the world, but not occurring in the Hawaiian Islands. *P. Friedrichsthalianum* (Berg) Niedenzu, is a well-known Costa Rican species; *P. Araça* Raddi grows on the dry uplands of Brazil; and *P. montanum* Swartz is native to the mountains of Jamaica. The so-called black guava is *Guettarda argentea* Lam., a rubiaceous Jamaican tree, bearing black, globose, fleshy fruits. The "Chilean guava" is a myrtaceous shrub of

Chile (*Myrtus Ugni* Molina), 1–2 m. high, with dark green, shining, ovate leaves, white flowers, and edible, aromatic berries. The "pine-apple guava" of California is *Feijoa Sellowiana* Berg, a South American myrtaceous plant, which resembles the true guavas in growth and fruit.

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A new Lejunea from Bermuda and the West Indies*

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(WITH PLATE 24)

The species described below is not uncommon in the West Indies and is perhaps to be expected in Florida and Mexico. It seems to be most abundant at low altitudes, without being strictly coastal in its distribution. The material at first examined, which was scanty and incomplete, was confused with *L. glaucescens* Gottsche, and some of the Bermuda specimens have been listed under this name by the writer.† More abundant material has since been available and has shown conclusively that the species is amply distinct.

Lejeunea minutiloba sp. nov.

Pale or dull green, often somewhat brownish with age, scattered or growing in depressed mats: stems about 0.1 mm. in diameter, copiously and irregularly branched, the branches obliquely to widely spreading, often with slightly smaller leaves than the stem but not microphyllous: leaves contiguous to loosely imbricated, the lobe widely spreading, slightly falcate, plane or slightly concave, broadly ovate, when well developed about 0.5 mm. long and 0.45 mm. wide, dorsal margin usually arching partially or wholly across the axis, then strongly outwardly curved to the broad and rounded apex, ventral margin straight or slightly outwardly curved, margin entire or vaguely and minutely crenulate from projecting cells; lobule in the form of a minute triangular basal fold, consisting of only a few cells, the apex represented by a single projecting cell tipped with a hyaline papilla; cells of lobe averaging about 13 μ in diameter at the margin and 25 $\times$ 20 μ in the median and basal portions, thin-walled but with minute trigones and occasional intermediate thickenings, cuticle smooth: underleaves distant, orbicular, about 0.2 long, bifid about one half with erect, triangular, acute, obtuse or rounded divisions, rounded at the base, margin as in the leaves: inflorescence autoi-

* Contribution from the Osborn Botanical Laboratory.

† Bull. Torrey Club **33**: 131. 1906.

cous: ♀ inflorescence sometimes borne on a leading branch, sometimes on a more or less abbreviated branch, innovating on one side, the innovation sometimes sterile, sometimes with a second ♀ inflorescence; bracts obliquely spreading, varying greatly in size, distinctly complicate, lobe oblong to obovate, when well developed about 0.45 mm. long and 0.3 mm. wide but often considerably smaller, margin as in the leaves, lobule ligulate, rounded at the apex, about 0.16 mm. long and 0.06 mm. wide; bracteole mostly obovate, about 0.4 mm. long and 0.25 mm. wide, bifid one third or a little more with erect, acute, obtuse, or rounded divisions, margin as in the leaves; perianth obovoid, when well developed about 0.5 mm. long and 0.35 mm. wide, terete in the lower half, distinctly five-keeled above, narrowed toward the base, truncate or slightly retuse at the apex and with a short but distinct beak: ♂ inflorescence usually occupying a short branch and not proliferating, bracts closely imbricated, in two or three pairs, strongly inflated, shortly bifid with a crenulate, strongly arched keel and rounded divisions; bracteole usually single at base of inflorescence, smaller than the underleaves, bifid: capsule about 0.2 mm. in diameter.

BERMUDA: on rocks and stones, Church Cave and vicinity, July, 1900, *M. A. Howe 7;* February, 1908, *S. Brown 504, 505;* September, 1912, *E. G. Britton 1088;* on rocks and stones, Walsingham, June, 1900, *M. A. Howe 3;* September, 1905, *E. G. Britton 286;* gully, Tuckerstown, September, 1905, *E. G. Britton 323;* February, 1908, *S. Brown 516;* on bark and roots, Abbott's Cliff, September, 1912 and 1913, *E. G. Britton 888, 931, 932* (in part), *933, 1867;* on bark, without definite locality, 1908, *S. Brown 559a.*

CUBA: in a ravine and on roots of royal palm, San Luis, Oriente, April, 1909, *N. L. Britton 2327, 2329;* on shaded limestone, Tropical Park, Puentes Grandes, Havana, August, 1911, *Brother Leon 2739.*

PORTO RICO: on trunk of a tree, near Rio Piedras, January, 1899, *Mr. & Mrs. A. A. Heller 147;* near Bayamon, July, 1901, *Underwood & Griggs 892;* vicinity of Coamo Springs, March, 1906, *M. A. Howe 1371;* on bark and on earth, Lares to San Sebastian, April, 1913, *Britton & Marble 2799, 2800;* at base of tree, vicinity of Ponce, March, 1913, *Britton & Shafer 1747;* on bark, Candalaria, near Bayamon, February, 1914, *E. G. Britton 1521.*

ST. THOMAS: on banks and stones, St. Peter, February, 1913,

Britton & Marble 1251, 1254, 1255; on stones, Crown, February, 1913, *Britton & Marble 1365.*

No. 1365 from St. Thomas may be designated the type; a slight admixture of *L. pililoba* Spruce is present.

In the genus *Lejeunea* the lobule when typically developed consists of an inflated sac, ovate in outline, more or less involute along the free margin, and tipped by a single projecting cell with a hyaline papilla at its proximal base. The same general type of lobule is found in several other genera of the Lejeuneae, such as *Rectolejeunea*, *Ceratolejeunea*, and *Crossotolejeunea*. Unfortunately, in certain species of *Lejeunea*, the lobule often fails to show its typical structure and appears reduced in size or otherwise variously modified. In some cases a prolonged search may be necessary before inflated lobules can be demonstrated at all, and it is not unusual for poorly developed lobules to be associated with plants bearing perianths. In the species here proposed as new no inflated lobules whatever have been seen, although many plants, both with and without perianths, have been examined. The lobule in all cases observed has been in the form of a minute basal fold, consisting of only a few cells. It seems safe to assume, therefore, that lobules of this reduced type represent a constant feature of the species.

With respect to size, the leaves, perichaetial bracts and perianths of *L. minutiloba* exhibit a considerable range of variation, and on slender stems and branches the leaves may be scarcely half as large as on robust stems. The small bracts and perianths are associated especially with short female branches, the size varying approximately with the length of the branch. The smallest bracts and perianths, therefore, are usually to be found on branches which bear a single vegetative leaf in addition to the bracts. The underleaves and bracteoles are much less subject to variation in size than the leaves and bracts; they vary markedly, however, in the character of their apices. These are sometimes acute or even apiculate, sometimes obtuse, and sometimes broadly rounded.

Among related species it will be sufficient to mention *L. floridana* Evans and *L. glaucescens* Gottsche. The first is still known from Florida only, but the second is widely distributed in

tropical and subtropical America. Both species are somewhat larger than *L. minutifolia*, the leaves being often 0.7 mm. in length, but they agree with it in inflorescence and in having small orbicular underleaves. In both species, however, the lobules are frequently inflated and conform closely to the usual *Lejeunea* type. *L. floridana* is further distinguished by its much larger perichaetial bracts (often 0.8 mm. in length), by its more shortly bifid underleaves and bracteole, and by the crenulate keels of its perianth, projecting upward as horns. In *L. glaucescens*, the bracts approximate those of *L. minutifolia* in size but the lobules are usually distinctly pointed.

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Explanation of plate 24

LEJEUNEA MINUTILOBA Evans

The figures were drawn by the writer from the type specimen and prepared for publication by Mr. H. D. Rhynedance.

FIG. 1. Part of plant with two perianths, ventral view (male inflorescence not shown), × 45.

FIG. 2. Lobule of a stem leaf, × 250.

FIG. 3. Cells from the apex of a lobe, × 335.

FIG. 4. Cells from the middle of a lobe, × 335.

FIG. 5. Underleaf, × 110.

FIGS. 6–8. Bracts and bracteole from a single involucre, × 55.

FIGS. 9–11. Bracts and bracteole from a second involucre, × 55.

FIGS. 12–14. Bracts and bracteole from a third involucre, × 55.

FIG. 15. Bracteole from a fourth involucre, × 55.

FIG. 16. Lobule of a perichaetial bract, × 250.

FIGS. 17–20. Apices of various bracteole-divisions, × 110.

FIG. 21. Transverse section of a perianth in upper fourth, × 55.

INDEX TO AMERICAN BOTANICAL LITERATURE

1913-1917

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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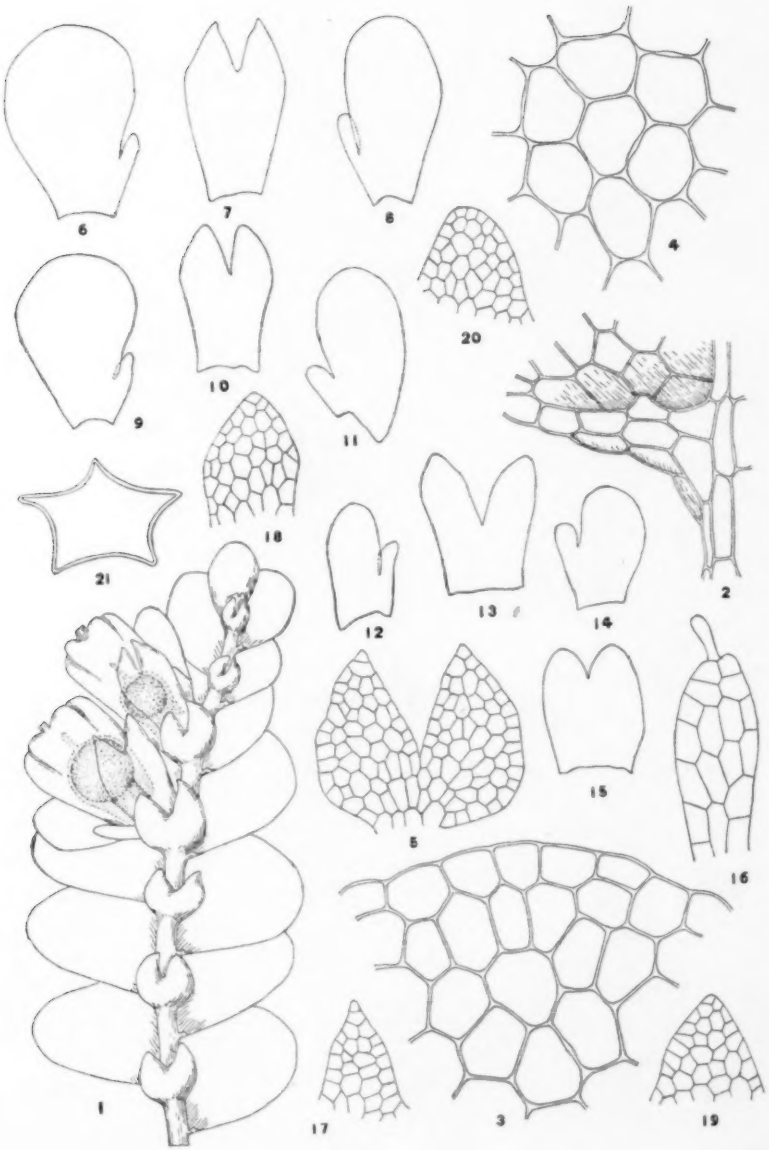

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